In the case of some plants, particularly maize and other Gramineæ, ammonia is by no means of inferior value to nitric acid, for Mazé was able to obtain as great an increase in dry weight in maize, using at most a one half per cent. solution of ammonium sulphate, as when he supplied it with a solution of a nitrate. Similar results were obtained in cultures of *Brassica* and species of *Allium*. Forest trees also must be dependent on ammonia, since nitrates are seldom present in woodland soils.

So far as we know at present it is quite certain that in addition to plants which definitely prefer nitric acid (*e. g.*, buckwheat, potatoes, turnips) there are others which get on just as well or even better with ammonia.

Perhaps after all the most conclusive proof that plants in nature can do well without nitrates comes from the fact that certain peat soils have been shown to be devoid of nitrates, yet they amply support plant growth. Again, rice responds well to ammonia even in soils where no nitrification can be detected.

Also it is true that we, as well as other investigators, have shown that soils very low in nitrification may be very productive and that on such soils plants respond readily to organic matter or ammonia, indicating that nitrification is often not an essential factor to soil fertility.

The general conclusion regarding the availability of ammonia and nitrate-nitrogen is that both can be used by many plants; that often nitrate nitrogen applied in the field gives larger crop yields. But the relative availability of these nitrogenous substances for crop plants under natural conditions has not yet been determined. This is an essential desideratum. A question that must be answered conclusively before we can know the significance of nitrification and dentrification.

It seems after all that ammonification is the essential thing and that nitrification is relatively unimportant, but this is only indicated, not proved.

There is need of rigid proof as to the relative availability to each crop plant of ammonia and of nitrate nitrogen. Then we shall know the true importance of the problems of nitrification and of denitrification. Following this knowledge will come the questions of correcting such evils as need correction, the heightening of nitrifying power in cases where this is low and where higher nitrification would be of advantage; the lowering of denitratation if this be a disadvantage and where it is a disadvantage.

Plant physiology must join hands with soil bacteriology to ascertain which are the significant problems that conditions of deficiency may receive correction.

F. L. Stevens

College of Agriculture,
Mayaguez, Porto Rico

Reactions of Young Lobsters Determined by Food Stimuli

In recently glancing through some old notes written several years ago, when the writer was interested in problems relating to the behavior of the larval lobster (*Homarus americanus*), certain unpublished data regarding the reactions to food-stimuli came to light. It is the aim of the present note to give some of these data, which may be regarded as supplementary to the material published in 1908,[1] terminating the writer's investigations on the subject of behavior of *Homarus*.

Many students of animal behavior have learned that the condition of hunger is able to greatly modify the reactions of organisms to many stimuli—especially to food. Generally speaking, it has been found that hunger prevents the manifestation of certain normal types of reaction. The effect of hunger upon certain stages of *Homarus* is no exception to this rule. In this instance, however, the condition of hunger has been thus far found instrumental in modifying the reactions of the lobster only in the fourth and later stages, for similar experiments upon lobsters in the earlier stages have not yet been made. One reason for this is the fact that the larval lobsters of the first three stages are not able to direct their own activity in a definite direc-

[1] "The Behavior of the Larval and Early Adolescent Stages of the American Lobster (*Homarus americanus*)," *Journ. Comp. Neurol. and Psychol.*, 1908, 18, (3), 199–301.

tion, as toward food; and it is not until the fourth stage is reached that the lobster can be truly said to be master of its own movement. It was learned in the early stage of the investigations on the behavior of the fourth-stage lobsters that, if any study at all was to be made of their reactions to light, the lobsters must first be fed—and well fed. For, if such was not the case, the tendency to eat one another usually annihilated any possible manifestation of a response to the influence of light or other stimuli. Even if the condition of hunger did not excite these extreme cannibalistic instincts, and so preclude all experimentation, it produced a manifestation of unrest which made any results in the way of numerical counts impossible. As has been shown in earlier papers, the fourth stage-period, at least in the early part, is typically a "swimming-period"—the "swimming-period" *par excellence* of the lobster's whole existence. It is not until the latter part of the fourth stage-period that the lobster, under the proper conditions of environment, goes to the bottom and begins to burrow in the sand or under the bits of shell. Now it was found that the condition of hunger appeared to have a very definite influence upon the time at which this burrowing "instinct" was first "liberated" in the fourth-stage lobster. To determine this point, several experiments were performed of which the following is a fair example of all.

Experiment A

Influence of Hunger on "Burrowing."—On August 5 about thirty early four-stage lobsters were taken from one of the confinement bags, in which they were being reared. They did not show much evidence of hunger and were therefore isolated for 48 hours without food. At the expiration of this time, all proved to be very hungry. Now two groups of five lobsters each were taken from this lot, and each group was placed in a 14 cm. crystallization dish, the bottom of which was covered with sand, gravel and shells. Immediately after this, one group of lobsters was fed with chopped clam meat; the other group was left hungry. The dishes were then placed on the laboratory table, and records were taken frequently to ascertain at what time the burrowing would be first manifested; and in which group of lobsters—the fed or the unfed. For some little time the members of both groups swam more or less constantly at or near the surface. Further records, which show the time of burrowing of the individuals in the two groups, may be presented as follows:

Time	Group Fed	Group Unfed
Aug. 7, 10:00 A.M.	1 larva burrowed.	5 larvæ swimming or crawling.
Aug. 7, 11:30 A.M.	2 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 7, 3:30 P.M.	3 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 8, 9:00 A.M.	4 larvæ burrowed.	5 larvæ swimming or crawling.
Aug. 9, 9:00 A.M.	4 larvæ burrowed.	3 larvæ burrowed.[2]
Aug. 9, 6:00 P.M.	4 larvæ burrowed.	4 larvæ burrowed.

These results appear to show that hunger may postpone the liberation of the burrowing instinct, while satiety appears to favor its early appearance. One other experiment, and the converse of the previous case, may be introduced.

Experiment B

Influence of Food-stimulus upon Surface-swimming in the Fourth-stage Lobsters.—In this case about twenty mid and late fourth-stage lobsters were placed in a glass jar 25 cm. in diameter filled with salt water to a depth of 10 cm. These lobsters were kept without food until they showed evident signs of hunger. All the lobsters remained on the clean bottom of the jar, over which they crawled or lightly swam. Occasionally one would come to the surface, only to leave it again for the bottom of the jar. Now a long pipette was partly filled with fresh clam juice, and the outside of the pipette carefully washed to take away all possible trace of clam odor

[2] At this point in the experiment one of the five lobsters was killed and eaten by the others, three of which immediately burrowed.

from the surface of the tube. When the lobsters were found to be resting quietly on the bottom of the dish, the point of the pipette was slowly lowered to the very bottom of the jar, where a few drops of clam juice were liberated in the vicinity of the fourth-stage lobsters. Within a few seconds all the lobsters in that region rose immediately to the surface of the water and swam wildly about for a variable length of time, after which they again went to the bottom of the jar. Here they either rested permanently or, if a sufficient amount of the clam juice remained near the bottom of the jar, apparently restimulated, the lobsters manifested further surface-swimming. These same tests were tried on the fifth-stage lobsters, but, although the clam juice might excite them to more active crawling over the bottom of the jar, it never produced surface-swimming, as in the case of the fourth-stage lobsters. These observations have received further support from the facts which the writer once learned from Dr. V. E. Emmel. It appeared in his case that the hungry lobsters with which he chanced to be working, when stimulated by a piece of clam meat dropped into their confinement bottles, would not remain on the bottom to enjoy the morsel, but would rise to the surface and manifest active swimming for some moments. These few observations demonstrate clearly that the lobsters, at least of a certain age, respond very definitely to certain kinds of food-stimuli. To what extent this kind of reaction may be responsible for the surface-swimming so characteristic of the early fourth-stage lobsters under natural conditions it is difficult to say. It is not improbable, however, that, after the fast which usually accompanies the approach of the third moulting-period the great hunger which characterizes the early fourth-stage lobster may be, in part, at least, the cause of the surface-swimming, although, as has been shown in previous publications, the reaction to light is also no doubt an influential factor.

PHILIP B. HADLEY

KINGSTON, R. I.,
January 22, 1912

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 458th regular meeting of the society was held in the new National Museum at 4:45 P.M. on February 6. Professor Mitchell Carrell presented a paper entitled "The Excavations at Knossos or Labyrinth of Minos," illustrating his talk with the lantern.

ON February 20 the retiring president, Dr. J. W. Fewkes, made an address on "Great Stone Monuments in History and Geography," at eight o'clock in the new National Museum. Dr. Fewkes's paper will appear in full in the Smithsonian Miscellaneous Collections.

THE 459th regular meeting of the society was held in the new National Museum at 4:45 P.M. on March 12. Miss Densmore read a paper on the "Sun Dance of the Teton Sioux." This paper was based upon a study of the sun dance made among the Teton Sioux on the Standing Rock reservation in North Dakota and represents the sun dance usage in that band of the tribe. The study was conducted in a series of councils to which the old leaders of the tribe came from a radius of about a hundred miles. Fifteen reliable men were selected to give the account of the sun dance, their authority being established by interviews with about forty members of the tribe, in widely separated localities. Those who took part in the sun dance councils were men who bore upon their bodies the scars of their participation in the sun-dance tortures, and among them were the man who acted as intercessor in the ceremeny and the man who "did" the cutting of those who fulfilled vows, both men being the only Tetons living who had performed these official acts. The men comprising the sun-dance council, with the writer and an interpreter, visited the site of the last sun dance held by the Teton Sioux in 1882, the site being identified by the Indians. The place where the sun-dance pole was erected, the outline of the "shade-house" and the location of the "sacred place" were recognized and measurement showed them to be correct, according to the usual plot of the sun-dance grounds.

The sun dance was held annually by the Sioux and was distinctly a religious ceremony. The fulfilling of vows of torture was an important part of the ceremony, the vows having been made by men in danger on the warpath. When making the vow they asked